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(54) **Process of preparing an ink blend matching a colour sample**

(57) The hue of a printing ink is adjusted in accordance with a colour sample before or during a printing operation. Desired values for the hue, the color strength and the saturation are determined in accordance with the color sample, the luminance factors of the color sample are ascertained by densitometric measurements using blue, green and red filters, an ink concentrate is prepared from a number of predetermined basic colors in accordance with the hue values which result from the measured density values, extender is admixed in the quantity required to obtain the desired color strength, and black is admixed to obtain the desired saturation. During printing, the luminance factors can be monitored and the blend adjusted to maintain the required colour match.

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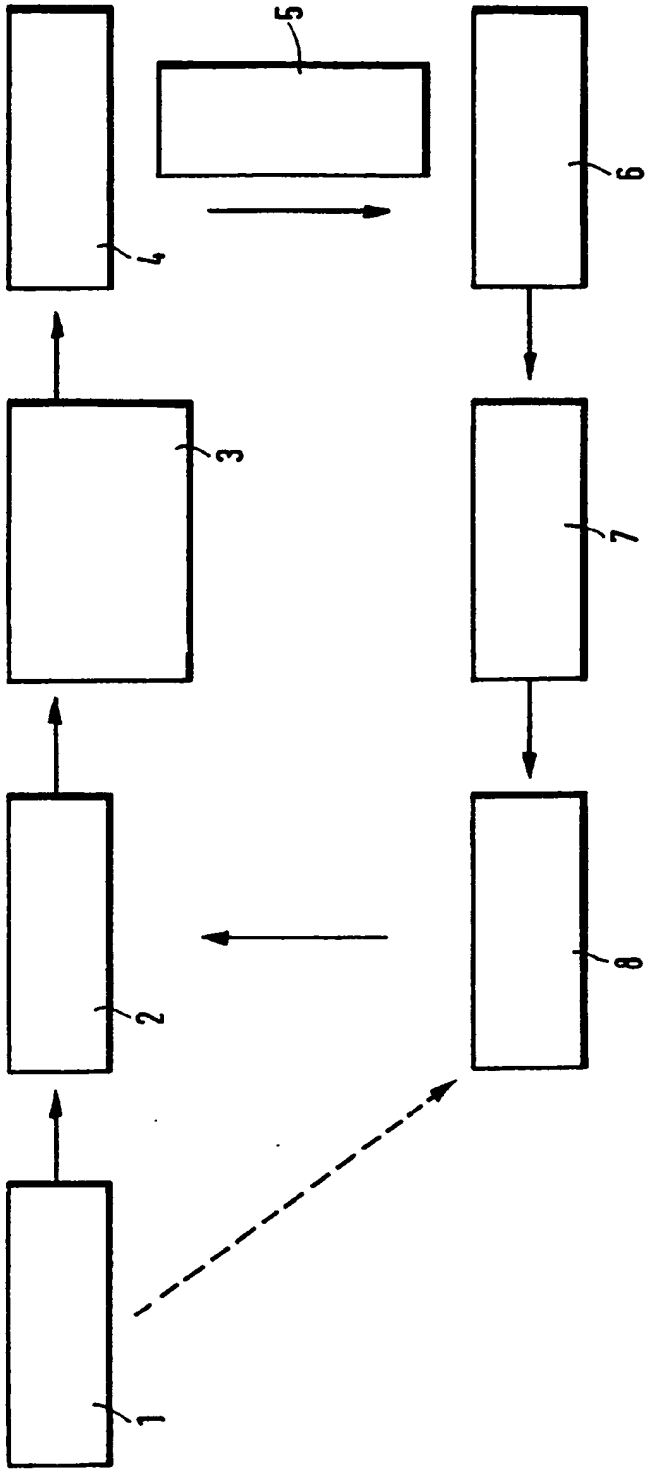

FIG.1

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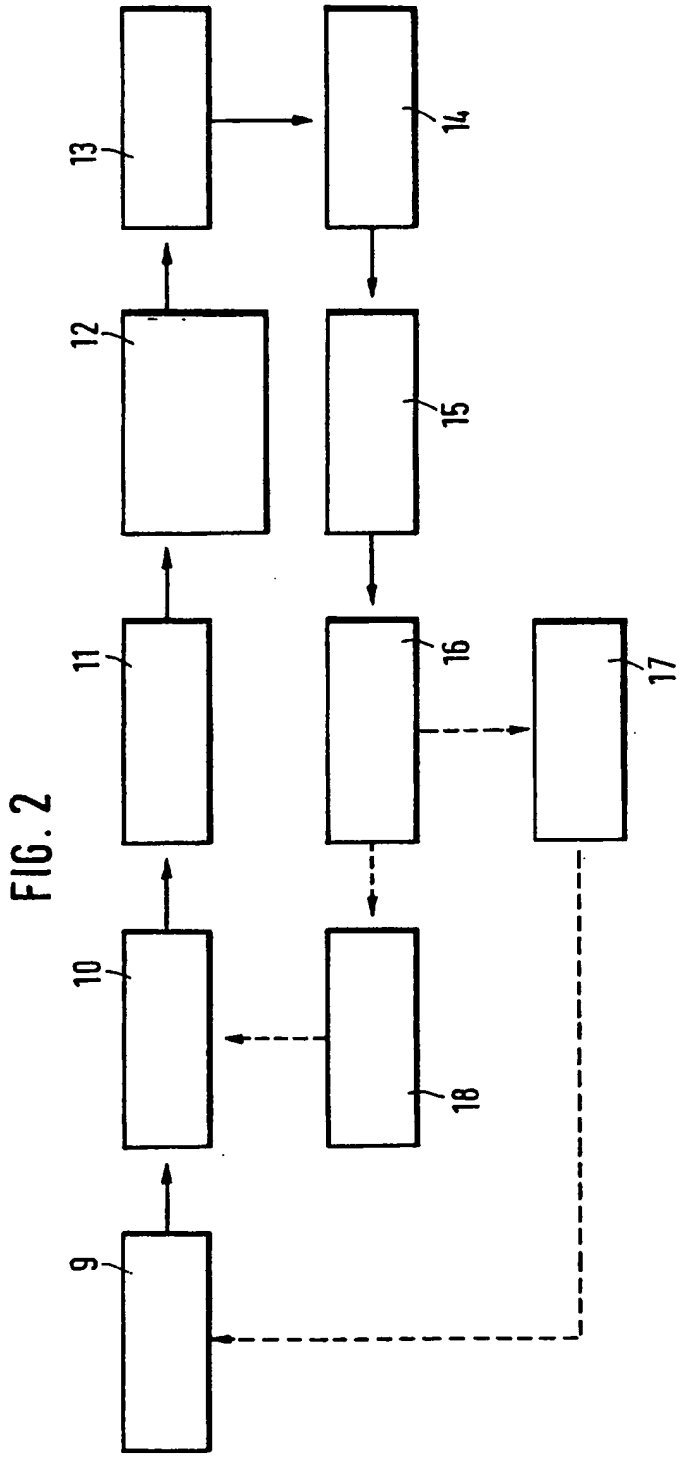

FIG. 2

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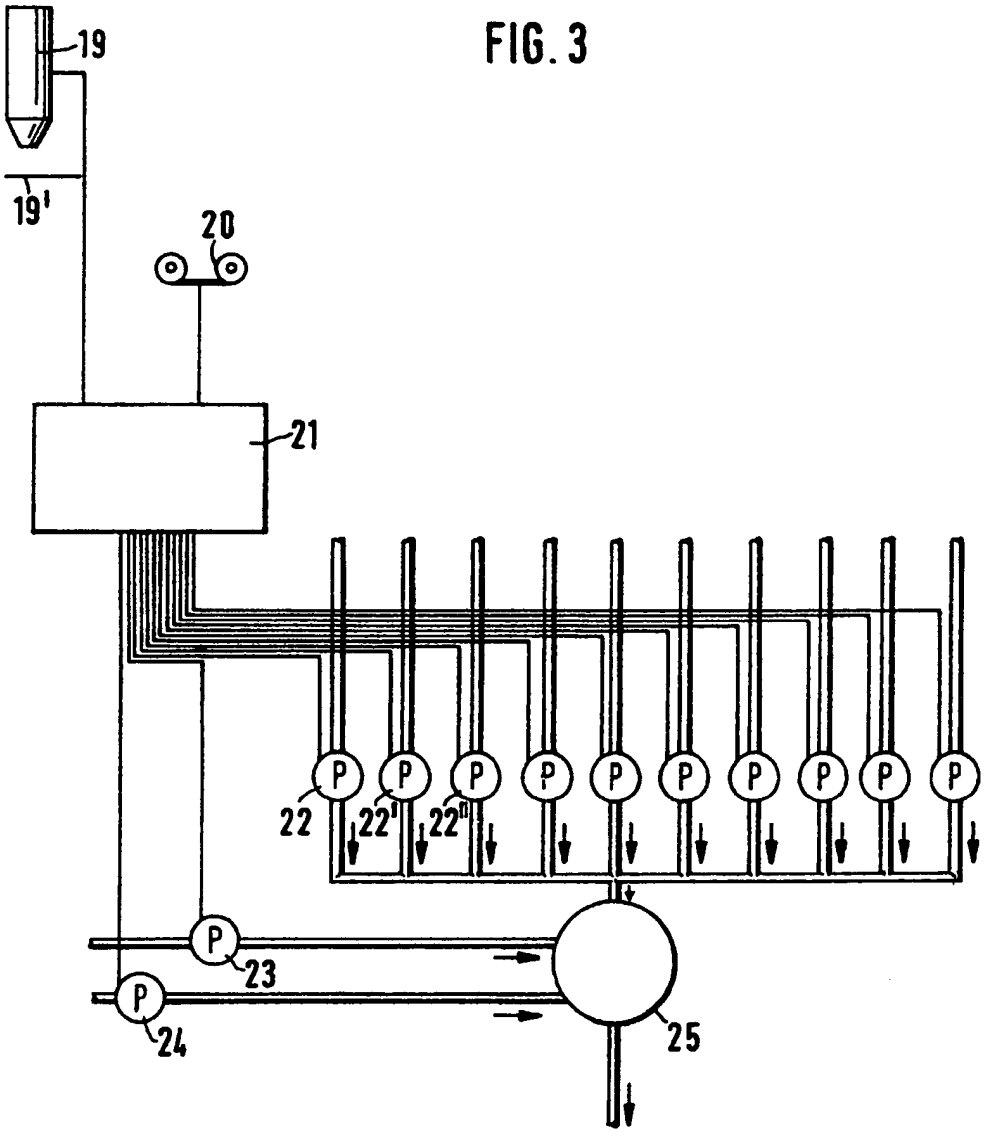
FIG. 3



SPECIFICATION

Process of preparing an ink blend matching a color sample, particularly an ink for a multicolor printing

This invention relates to a process of preparing an ink blend matching a color sample, particularly an ink for multicolor printing, wherein the solvent content and the extender content of the ink blend are adjusted to predetermined, desired values.

In multicolor printing, the previous practice was for the printing offices to send a color sample to the maker of the printing inks, who then endeavored to blend a plurality of inks in primary colors so as to provide a hue which matched the color sample. In this practice, the person who provided the ink blend matching the color sample has to rely on his or her experience and on the continual optical comparison between the sample and the hue of the blend obtained. It will be understood that this method of blending inks is time-consuming and often unsatisfactory. The ink which has been made by the inkmaker in this manner and has the hue resulting from the blending of inks is then supplied to the printing office in concentrated form.

Because the printed colors change in dependence on the thickness of layer as a result of the use of different ductors, screen rollers, contact pressures, roller coverings and other properties of the machine, it is necessary in the printing office that the ink charged into several ink boxes is adjusted to a lighter shade, e.g., by admixing of extender, and to a desired viscosity by an addition of diluent. In rare cases, in which the color does not have the required strength, the ink may have to be adjusted to a higher color strength by an addition of ink concentrate. All these blending operations will not change the hue, which is determined by the ink concentrate blended by the inkmaker.

Printing will not produce uniform results unless the color strength of the ink remains constant throughout the printing operation. This has previously been accomplished only by an admixing of concentrate, extender or diluent. The printer usually had to rely entirely on his eye.

German Patent Publication 24 10 753 discloses a process which is of the kind stated first hereinbefore and in which each ink duct of an inking unit of an intaglio printing machine is supplied with an ink composed of a solvent, an extender and an ink concentrate. In order to maintain the properties of the ink constant during the printing operation, a proportioning device is provided, which comprises a set point adjuster for adjusting the percentages of solvent, extender and ink concentrate in the ink. Another apparatus for performing the known process comprises a device which serves to measure the color values and for that purpose continually samples the printed web at marks printed on the web; the measured values are then compared with the desired colour values which have been adjusted. When a difference occurs, new desired values for the composition of the ink are computed in order to cause the printed color values which have been measured to approach the desired color values which have been adjusted.

In the apparatus disclosed in German Patent Publication 24 10 753 the manually adjustable set point adjuster can be replaced by a reference input computer, which is fed with a measured value obtained by a sampling device, which samples the color values, e.g., the color density, of marks which are continually printed with circulating ink on the substrate in the printing unit. In the reference input computer the measured color values are compared with the desired color values. When there is a difference between the desired and actual values, the computer will compute such a desired color value that during the next refilling operation controlled by the proportioning device the composition of the circulating ink will be changed so that the printed color values will approach the desired color value.

In the known process, only the strength and brightness of the color can be controlled in accordance with predetermined desired values. But it is still necessary to use in each printing unit an ink concentrate which cannot be changed in composition so that difficulties in the preparation of the printing inks remain and the hues of the several inks cannot be changed by the printer.

In the process of controlling printing machines disclosed in German Early Disclosure 20 11 979, the desired color density (color strength) is maintained constant during the printing operation. For this purpose, each printing cylinder prints also a color strip, which is used for densitometric measurement. The value thus measured is fed as an actual value to a comparator circuit and is compared therein with a desired value. The means for adjusting the ductor and the zone-adjusting screws of the color-measuring device are adjusted in dependence on the detected deviation from the desired value.

In the process of maintaining constant the color strength of the print produced by printing machines disclosed in German Early Disclosure 22 03 145, the colour strength (degree of coloration) of the print is measured, the actual value obtained by the measurement is compared with the desired color strength, and the color strength is caused to approach the desired value in dependence on the difference between the desired and actual values.

These known processes also permit only a change of the color strength during the printing operation but do not permit an adjustment of the hue in accordance with a color sample before or during the printing operation and still require that the concentrate used in the ink ducts of the several printing units is prepared in the manner described first hereinbefore.

It is an object of the invention to provide a process which is of the kind described first hereinbefore and permits the printer to automatically prepare for each ink duct of the printing units an ink having the correct hue, the correct saturation and the correct color strength in accordance with the color samples.

This object is accomplished according to the

invention in that desired values for the hue, the color strength and the saturation of the color blend are determined in accordance with the color sample, the luminance factors of the color sample are ascertained by densitometric measurements using blue, green and red filters, the concentrate is prepared from ink concentrates corresponding to a number of predetermined primary colors in accordance with the hue values which result from the measured density values, the extender is admixed in the quantity required to obtain the desired color strength, and black is admixed to obtain the desired saturation. In the process according to the invention, the ink concentrate to be charged to the ink ducts is no longer blended by the inkmaker but is composed of predetermined inks in accordance with results of densitometric measurements so that the hue of the concentrate used will objectively match the color sample and the hue of the concentrate employed no longer depends on the subjective judgment of the inkmaker.

The process according to the invention can be carried out in a particularly advantageous manner with the aid of microprocessors and microcomputers. The results of the densitometric measurements can be fed to a microcomputer, which will then compute the composition of each ink blend and will control the means for controlling the discharge from the containers for the several ink components. In carrying out the process according to the invention, the density values measured by the densitometer provided with the red, green and blue filters are suitably converted to coordinates of a cylindrical system of coordinates, in which the angle in degrees, measured around the axis of the cylinder, represents the hue, the height in metric units over the bottom surface represents the color strength, and the horizontal distance in metric units from the axis of the cylinder axis represents the saturation of the color sample. In that system, the corners of a polygon inscribed in any circular cross-section of the cylinder will be determined by the vectors of the inks which are available for blending the printing ink. In that polar system of coordinates, the angular position of the vector (point of intersection of the vector or of its extension with the straight line connecting two color loci of the polygon — said straight line is called blending line) will determine the hue (ratio of the inks on opposite sides of the straight line in the blend) and the length of the vector will determine the saturation (proportion of black to be admixed). In a given system, all colors lying within the polygon can be blended from the inks which are available.

In multicolor printing, each color which has been printed is suitably measured by means of a manual or machine-operated densitometer and the contents of the components of the blend (ink concentrate, extender and solvent) are changed accordingly when the measured actual value deviates from the desired value which is given by the color sample.

The quantity in which each component of the blend is to be admixed can be controlled in a simple manner by the selection of the number of strokes of a positive-displacement piston pump.

The color which can be achieved can be sufficiently covered if the concentrates of more than three inks, e.g., of seven or eight inks, are held available for use in blending the hue.

The known process of controlling only the color strength and the process according to the invention of preparing ink blends having the correct hue and the correct color strength will be explained more fully hereinafter with reference to the accompanying drawing, in which

Figure 1 is a diagrammatic representation of the known process for maintaining a constant color strength,

Figure 2 is a diagrammatic representation of the process of blending printing inks to match a sample and

Figure 3 is another diagrammatic representation of the process according to Figure 2.

The processes known in the art can be used to maintain a constant color strength of printed colors in accordance with a predetermined desired value. That desired value is indicated by a unit 1, which measures the luminance of a sample, or results from the preadjustment of a proportioning unit corresponding to the percentages of the components of an ink having the desired composition. In accordance with the desired value which has been measured or adjusted, the proportioning devices 2 deliver concentrate, diluent and extender to a blender 3, which then delivers the ink to an ink container 4, e.g., an ink duct of a printing machine. The printing rollers 5 are used to apply the ink to the paper which is to be printed. Additional color marks are printed on the paper 6 and their color density values are measured with a densitometer 7. The result of the measurement is delivered to a comparator 8, which compares the desired and actual values and in response to a deviation from the desired value control the proportioning devices 2 accordingly.

In the process which is diagrammatically shown in Figure 2, the luminance factors of the color sample are measured in succession or simultaneously by a densitometer provided with blue, green and red filters. From the three density values which have been measured, a process computer 10 computes the desired values of the contents of the several components of the ink to be blended. These desired values are fed to a set point adjuster 11. In accordance with said desired values, a proportioning device 12 delivers the several components of the ink to be blended to the blender 13 in the correct proportions. The ink formed in the blender 13 by the blending of inks in several primary colors, at least three of which must be available, and of the extender and diluent is discharged as printing ink into the ink container 14. The paper 16 to be printed is printed with the several printing inks by means of the printing cylinders 15. Samples 17 are taken from the printed paper and are measured with the manual

densitometer. If a sample indicates a deviation from the desired values which have been computed, then the means for controlling the porportioning devices 12 will be corrected accordingly.

Alternatively, a machine-operated densitometer 18 may be used to continually monitor color marks printed on the paper and to feed any deviations that have been detected to the process control computer so that the latter computes corrected positions for the means for controlling the proportioning devices 12.

The ink blending system shown in Figure 2 will be more readily understood by reference to the diagrammatic representation of Figure 3. The densitometer 19 provided with blue, green and red filters is used to measure the luminosity factors of the color sampe 19'. The results of the measurement are fed to the process control computer 21, the program of which is stored on a magnetic tape 20. In dependence on the desired values which have been computed, the process computer controls the porportioning pumps 22, 22', 22" ..., which withdraw ink concentrates in the available colors from storage tanks and feed said concentrates to the blender. Additional pumps 23 and 24 are controlled by the computer and charge the blender 25 with extender for brightening and with diluent for controlling the viscosity of the ink. The ink blend which matches the color sample is fed from the blender 25 to the ink container of the printing machine.

By means of the process explained with reference to Figures 2 and 3, each ink desired in the printing office can be prepared in the printing office in very short time and it will not be necessary for the ink concentrate for each printing unit to be blended by the inkmaker or by another person who would have to rely on his or her experience or his or her good visual judgment. In this connection it makes no difference whether the color sample is a secondary color or a so-called pure color, such a magenta. The luminosity factors of magenta are also measured in succession or simultaneously through the three filters. The three density values which have been measured are then fed to the process control computer, which converts said values to the required number of strokes of piston pumps of the proportioning devices. The computed number of strokes of each pump is fed to a positioning device, which energizes the motors of the several proportioning pumps and de-energizes each motor when strokes in the number computed by the computer for the respective pump have been counted, e.g., by means of cams and counters. The number of pumps is variable and corresponds to the number of inks in the primary colors which are available for blending the several printing inks plus one pump for the extender (for brightening) and one pump for the diluent (for adjusting the viscosity).

It is suitable to make inks available not only in three primary colors but in seven colors so that seven pumps for the inks and two pumps for the extender and diluent respectively, will be required. The color space which can be covered will be increased when more starting inks are available. It will be particularly desirable to use inks in eight primary colors. In this case the color space which can be obtained is adequately covered.

As the process proceeds, ink concentrate, extender and any diluent are fed in the quantites delivered by the respective pumps to a blender and from the latter to the respective ink containers. During the printing operation, the luminosity factors of the printed colors can be measured with the aid of three filters either by a machine-operated densitometer or at samples taken from the printed web with the aid of a manual densitometer. The actual values thus ascertained are delivered to the computer, which compares them with the desired values and computes correction values for the means for controlling the proportioning devices. As long as the printing machine is being set up, the taking of samples from the printed paper web or the measurement effected by means of the machine-operated densitometer is repeated until the computer does no longer indicate correction values. As the printing operation proceeds, the agreement with the desired value is again checked by a taking of samples or by a measurement effected with a machine-operated densitometer.

CLAIMS

1. A process of preparing an ink blend matching a color sample, particularly an ink for multicolor printing, wherein the solvent content and the extender content of the ink blend are adjusted to predetermined, desired values, characterized in that desired values for the hue, the color strength and the saturation of the color blend are determined in accordance with the color sample, the luminance factors of the color sample are ascertained by densitometric measurements using blue, green and red filters, tha concentrate is prepared from ink concentrates corresponding to a number of predetermined primary colors in accordance with the hue values which result from the measured density values, the extender is admixed in the quantity required to obtain the desired color strength, and black is admixed to obtain the desired saturation.

2. A process according to claim 1, characterized in that in multicolor printing each color which has been printed is measured by means of a manual or machine-operated densitometer and the contents of the components of the blend (ink concentrate, extender and solvent) are changed accordingly when the measured actual value deviates from the desired value which is given by the color sample.

3. A process according to claim 1 or 2, characterized in that the quantity in which each component of the blend is admixed is controlled by the selection of the number of strokes of a positive-displacement piston pump.

4. A process according to any of claims 1 to 3, characterized in that concentrates of more than

th ›s starting inks, preferably seven or eight inks a .ɛɔt available for the blending of the hue.

A process for preparing an ink blend matching a color sample substantially as hereinbefore described with reference to Figures 2 and 3 of the accompanying drawings.

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